

Weathervane Scallop Dredge Survey Operational Plan, 2021–2023

by

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Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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Weights and measures (metric)		General		Mathematics, statistics		
centimeter	cm	Alaska Administrative Code		all standard mathematical signs, symbols and abbreviations		
deciliter	dL		AAC			
gram	g	all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.	alternate hypothesis	H _A	
hectare	ha			base of natural logarithm	<i>e</i>	
kilogram	kg	all commonly accepted		catch per unit effort	CPUE	
kilometer	km	professional titles	e.g., Dr., Ph.D., R.N., etc.	coefficient of variation	CV	
liter	L			common test statistics	(F, t, χ^2 , etc.)	
meter	m	at	@	confidence interval	CI	
milliliter	mL	compass directions:		correlation coefficient		
millimeter	mm	east	E	(multiple)	R	
Weights and measures (English)		north	N	correlation coefficient (simple)	r	
	cubic feet per second	ft ³ /s	south	S		
	foot	ft	west	W	covariance	cov
	gallon	gal	copyright	©	degree (angular)	°
	inch	in	corporate suffixes:		degrees of freedom	df
	mile	mi	Company	Co.	expected value	<i>E</i>
	nautical mile	nmi	Corporation	Corp.	greater than	>
	ounce	oz	Incorporated	Inc.	greater than or equal to	≥
	pound	lb	Limited	Ltd.	harvest per unit effort	HPUE
	quart	qt	District of Columbia	D.C.	less than	<
yard	yd	et alii (and others)	et al.	less than or equal to	≤	
Time and temperature		et cetera (and so forth)	etc.	logarithm (natural)	ln	
		exempli gratia		logarithm (base 10)	log	
	day	d	(for example)	e.g.	logarithm (specify base)	log ₂ etc.
	degrees Celsius	°C	Federal Information Code		minute (angular)	'
	degrees Fahrenheit	°F		FIC	not significant	NS
	degrees kelvin	K	id est (that is)	i.e.	null hypothesis	H ₀
	hour	h	latitude or longitude	lat or long	percent	%
	minute	min	monetary symbols		probability	P
	second	s	(U.S.)	\$, ¢	probability of a type I error	
	Physics and chemistry		months (tables and figures): first three		(rejection of the null hypothesis when true)	α
all atomic symbols			letters	Jan,...,Dec	probability of a type II error	
alternating current		AC	registered trademark	®	(acceptance of the null hypothesis when false)	β
ampere		A	trademark	™	second (angular)	"
calorie		cal	United States		standard deviation	SD
direct current		DC	(adjective)	U.S.	standard error	SE
hertz		Hz	United States of America (noun)	USA	variance	
horsepower		hp			population	Var
hydrogen ion activity (negative log of)		pH	U.S.C.	United States Code	sample	var
parts per million		ppm	U.S. state	use two-letter abbreviations		
parts per thousand	ppt, ‰		(e.g., AK, WA)			
volts	V					
watts	W					

REGIONAL OPERATIONAL PLAN NO. ROP.CF.4K.2021.09

**WEATHERVANE SCALLOP DREDGE SURVEY OPERATIONAL PLAN,
2021–2023**

by

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November 2021

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SIGNATURE PAGE

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PURPOSE

The goal of this standardized scallop dredge survey is to produce long-term fishery-independent indices of relative abundance of weathervane scallops *Patinopecten caurinus* for the primary harvest locations that support Alaska's commercial scallop fishery. The resulting data will be used to estimate area-swept scallop abundances, round-weight biomass, shell height, and age distributions and subsequently facilitate the development of a stock assessment model to inform the management of Alaska's weathervane scallop resources.

Key words: weathervane scallops, *Patinopecten caurinus*, Alaska, biomass, abundance

BACKGROUND

Weathervane scallops *Patinopecten caurinus* are distributed throughout the northeast Pacific Ocean from Pt. Reyes, California north to the Pribilof Islands in the Bering Sea, and west to the Aleutian Islands (Foster 1991). Weathervane scallops are the largest scallops in the world and attain ages between 20 and up to 28 years in Alaska waters (Hennick 1973; Bechtol et al. 2009). Scallops are typically found on the continental shelf in discrete aggregations known as *beds* in a wide variety of habitats ranging from rock and gravel to silt and mud (Hennick 1973). Scallop beds are usually elongated or elliptical and are oriented in the direction of prevailing currents that typically parallel bathymetry (Kruse et al. 2000, 2005). Though scallops can be found in suitable habitat from the intertidal out to 300 m (~165 fathoms) (Foster 1991), they occur at densities that support commercial harvest between 55 and 146 m¹ (~30 and 80 fathoms).

The management strategy for Alaska's commercial weathervane scallop fishery is outlined in the federal Fishery Management Plan (FMP) (NPFMC 2014). The FMP delegates authority to the Alaska Department of Fish and Game (ADF&G) to manage most aspects of the scallop fishery in both state and federal waters. To date, the weathervane scallop fishery has been managed primarily using fishery-dependent data generated by onboard observers (NPFMC 2019). ADF&G currently requires 100% observer coverage on all vessels fishing for scallops outside the Cook Inlet Registration Area.

The collection of fishery-independent information about Alaska's weathervane scallop stocks began with ADF&G dredge surveys in the Cook Inlet and Prince William Sound registration areas (Figures 1 and 2). The program's inaugural surveys were conducted in Kamishak Bay in 1984 (Hammarstrom and Merritt 1985) and around Kayak Island in 1996 (Bechtol et al. 2003). Since 1996 biennial surveys have continued in these areas (Gustafson and Goldman 2012), enabling ADF&G to (1) delineate the primary scallop beds; (2) estimate scallop abundance and biomass within them; (3) characterize bed composition using age and shell height data; and (4) estimate catch rates of non-target species, particularly Tanner crab, *Chionoecetes bairdi*. Fishery managers in the Cook Inlet and Prince William Sound registration areas have used the results of these surveys to set guideline harvest levels (GHLs) and manage the commercial scallop fishery.

In 2016, ADF&G implemented an expanded dredge survey that both standardized existing survey efforts and expanded their scope to include more commercially important harvest

¹ Ryan Burt, Westward Region scallop program biologist, ADF&G Shellfish Observer Program, unpublished data, 2017–2019.

locations (Smith et al. 2016). The initial operational plan outlined the sampling of beds within the Kodiak Shelikof, Kodiak Northeast, Prince William Sound, and Yakutat fishery management districts (Table 1; Figures 1 and 2) on a rotating basis with the goal of establishing a fishery-independent data source to facilitate development of a stock assessment model to manage state scallop resources (Smith et al. 2016). This updated operational plan encompasses revisions to the sampling rotation, improvements to sampling methods, and represents an ongoing effort to modernize and consolidate the execution of this dredge survey with the goal of continuing to work towards the development of a stock assessment model.

OBJECTIVES

The objectives of this study are to:

- Estimate catch rates, abundance, and biomass of scallops in two size classes (≥ 100 mm shell height and < 100 mm shell height) by survey area;
- Collect biological data (e.g., sex, maturity, shell height, meat weight, age, etc.);
- Quantify other catch in number and weight, by species or higher taxonomic level;
- Collect oceanographic data (temperature, conductivity, depth, pH);
- Facilitate special research projects.

METHODS

SURVEY AREA AND DESIGN

For the purposes of this survey the spatial extent of scallop beds are defined by overlaying a grid pattern composed of 1 square nautical mile sections (stations) over commercial catch locations from the 1996/97 through 2014/15 fishing seasons. Only contiguous stations containing a cumulative round weight catch > 907 kg (2,000 lb) are used to define individual beds. Beds are considered the survey area from which population estimates are derived. Thus, this survey is examining trends in the exploited population, though there may be additional areas with exploitable levels of biomass. As historical information is reviewed, beds are surveyed, and new data become available, stations may be removed or added, and total bed area adjustments will be made in future Operational Plans following objective criteria (Table 12).

The dredge survey follows a systematic random design in which a starting point for selection is determined by randomly selecting a station from all currently active stations within a bed. Subsequent station selection continues to the east and west, with new rows to the south beginning on the west side of the bed and new rows to north beginning on the east side of the bed, until the full bed is covered (Thompson 1992). Once stations are selected, sampling may be done in any order.

A commercial scallop fishing vessel will be chartered to conduct the survey and will be chosen through a request for quotation. To offset operational cost, cost recovery will be allowed through the sale of scallops captured during the survey following data collection with scallops landed on an ADF&G Commercial Fisheries Entry Commission card. The allowance of cost recovery will be determined by shellfish management staff in the region the survey is taking place.

SAMPLE COLLECTION

The vessel captain, in cooperation with the cruise leader, will determine the specific haul location within each station based on the tide and sea state. Surveys will be conducted with a 2.44 m (8 ft) New Bedford style scallop survey dredge with 5.1 cm (2.0 in) inside diameter rings (Figure 3). To facilitate retention of small scallops, the ring bag is fitted with a 3.8 cm (1.5 in) polyethylene mesh liner. Dredge weight is approximately 816 kg (1,800 lb). Pitch and roll angle of the dredge will be measured using a Notus Dredgemaster dredge monitoring system. This system communicates acoustically between a sensor mounted on the dredge tongue and a hull mounted or towed hydrophone. Data are sent to a computer in the wheelhouse, displayed real-time, and recorded to hard drive for later analysis. Range (distance from the vessel to the dredge) and depth are also recorded. The update rate of the system is on average every 6 seconds but can vary with acoustic noise and depth. An analysis of pitch angle data collected during the 2017 statewide survey indicated that weathervane scallop catch was maximized at a 12-degree pitch.² This angle will be defined as the target pitch angle when conducting dredge tows. The Dredgemaster system will be calibrated prior to and following the survey.

The vessel will tow the dredge approximately 1.85 km (1 nmi) within each surveyed station. Vessel speed and scope will be adjusted as necessary to maintain the target pitch angle. Should the dredge monitoring system stop functioning during a survey, the target vessel speed will be 7 km/h (3.8 knots) with a 3.5:1 scope. The speed and scope values were developed by the Northeast Fishery Science Center using a 2.4 m dredge similar to that used in this survey (NEFSC 2015). All hauls will be conducted along a depth contour to minimize variation in dredge performance.

For each haul, all columns on the Fishing Log for Alaska Scallops Data Form (Appendix 1) will be completed. Additionally, if the survey vessel has the capability to track location, time, and depth of the tow path these data will be recorded.

CATCH SAMPLING

The on deck catch sampling will involve quantifying and collecting biological data on weathervane scallops, quantifying scallop predators, and characterizing and quantifying other catch (Appendix 2). Electronic motion-compensated scales and measuring devices will be calibrated at the beginning of each day, and prior to sampling in a different bed or if the sea state changes within the same day.

After the dredge is emptied, a photograph will be taken of the catch which will include a dry erase board in the frame indicating the survey cruise number and haul number.

Live Weathervane Scallops

Live scallops will be sorted into baskets by large (≥ 100 mm shell height), and small (< 100 mm shell height) size classes using a measuring stick. These size classes were chosen as 100 mm (~4 in) is the approximate size at which scallops are vulnerable to commercial fishing gear. These

² Ben Williams, ADF&G Fisheries Scientist I, to statewide scallop survey staff dated March 28, 2018, unpublished analysis (Standardizing dredge angle).

scallops will be counted and weighed in aggregate by size class and data recorded on the left side of the Scallop and Haul Composition Sampling Data Form (Appendix 3).

A random subsample of 10 individuals from each size class will be sampled for whole weight, sex, gonad condition, meat condition, shell height, shell damage, and presence of mud blisters and shell worms. Additionally, individual shucked meats from scallops of the large size class will be frozen at sea (meat weight will be determined in the laboratory) and from both size classes the top valve will be retained for age estimation. All data collected from these samples will be recorded on the Scallop Shell Height and Weight Form (Appendix 4). Another subsample of at least 40 scallops from each size class will be sampled for shell damage and shell height with data recorded on the Scallop Shell Height and Damage Form (Appendix 5). If the total number of scallops remaining from a size class is less than 40, all scallops of that size class will be sampled.

Sampled length frequencies will be proportionally allocated to the total catch count for large and small scallops, respectively.

Weathervane Clappers

Clappers are previously dead scallops that were obviously not killed in the current haul, typically with little or no soft tissue remaining in the shell, with both valves still connected at the umbo. Clappers are viewed as representing natural and unobserved fishing mortality because scallops that are shucked by processing crews are usually broken apart prior to discarding overboard. To obtain estimates of natural mortality, weathervane scallop clappers will be whole haul sampled, counted and weighed. These data will be recorded on the left side of the Scallop and Haul Composition Sampling Data Form (Appendix 3). All clappers will be broken apart before being discarded overboard to eliminate the chance of the clapper being caught and sampled again in future hauls.

Scallop Predators

Any catch of sunflower sea star *Pycnopodia helianthoides*, giant octopus *Enteroctopus dofleini*, wolf-eel *Anarrhichthys ocellatus*, Bering wolffish *Anarhichas orientalis* and all skate species Rajidae will be whole haul sampled, sorted to species, counted, and weighed. Skate egg cases containing live embryos will also be whole haul sampled, counted, and weighed. These data will be recorded on the left side of the Scallop and Haul Composition Sampling Data Form (Appendix 3).

Crabs

From all survey areas, catch of king crabs (red king crab *Paralithodes camtschaticus*, blue king crab *P. platypus*, golden king crab *Lithodes aequispinus*, brown box crab *Lopholithodes foraminatus*, red box crab *L. mandtii*), Dungeness crab *Metacarcinus* (or *Cancer*) *magister* and hair crab *Erimacrus isenbeckii* will be whole haul sampled, sorted to species, counted, and weighed.

Within the Kamishak Bay District (Figure 1), catch of Tanner crab ≥ 70 mm carapace width will be whole haul sampled, counted, and weighed. Tanner crab < 70 mm carapace width will be subsampled with the remaining catch (see Remaining Catch section below). From all other survey areas, catch of Tanner crab, snow crab *Chionoecetes opilio* and hybrid Tanner/snow crab will be subsampled with the remaining catch regardless of carapace width (see Remaining Catch

section below). These data will be recorded on the right side of the Scallop and Haul Composition Sampling Data Form (Appendix 3).

If biological data from crabs are collected, it will be recorded on the Crab Measurement Form (Appendix 6).

Pacific Halibut

Pacific halibut *Hippoglossus stenolepis* will be whole haul sampled, measured for fork length, and returned to the sea as quickly as possible. Fork length is defined as the greatest length from the most forward part of the head to the tip of the central rays of the caudal fin, with the fish lying straight and the mouth fully closed. The fork length measurements will be recorded in the *Catch Comments* section at the bottom of the Scallop and Haul Composition Sampling Data Form (Appendix 3).

Estimated weight in kilograms of measured fish will be determined using the halibut fork length to weight conversion list (Appendix 7) or using the standard length:weight formula³:

$$W_i = \alpha L_i^\beta * c$$

Where W_i is the individual weight estimate in kg, L_i is the measured fork length in cm, α and β are estimated constants ($\alpha = 9.165599e^{-6}$ and $\beta = 3.240811434$), and c is the ratio of lb to kg (0.45359237). Record this weight in the *Haul Composition* section on the right side of the Scallop and Haul Composition Sampling Data Form (Appendix 3).

Remaining Catch

Remaining catch will be subsampled by filling a tote (13L; 46 x 30 x 15 cm) with a shovel, sorted to species (or taxonomic group), counted, and weighed. Due to the excessive volume caught, brittle stars will only be weighed. To calculate the subsample fraction for expanding subsampled counts and weights, all remaining catch will be collected into baskets with shovels, weighed and recorded as *Unsorted Catch*. These data will be recorded on the right side of the Scallop and Haul Composition Sampling Data Form (Appendix 3). The *Catch Comments* section at the bottom of this form is available for remarks related to unusual catch composition, catch sampling issues, or other noteworthy observations.

SHELL AGE ESTIMATION

Based on historical shell height size ranges and the findings of Coggins et al. 2013, collected shells will be randomly chosen for age estimation from each of the following shell height (measured in millimeters) bins: 0-25, 26-50, 51-75, 76-77, followed by two-millimeter shell height bins up to 200 mm. Random sampling will be stratified across beds and size bins to account for area effects with a target sample size of at least 650 shells total. If this method regularly samples less than 10 shells per bin, or under samples compared to Coggins et al. 2013 target sample size of 500-1000 individuals, the number of samples per bed and size bin will be increased.

³ Richard Shepard, ADF&G Analyst/Programmer IV, estimated by Gregg Rosenkranz retired ADF&G Biometrician II using length and round weight (lb) values from IPHC 2003. Halibut Length/Weight Chart (Imperial).

A random subset of the shells selected for age estimation will be measured for annual increment spacing (shell height at age). These shells will be imaged using a high-resolution scanner and the increments will be measured using image analysis software. Power analysis will be performed on collected data in a growth model context to adjust sample sizes. Shell height at age will be determined for the smallest unit possible (e.g., bed or district) depending on sample sizes, using the von Bertalanffy growth equation (von Bertalanffy 1938; Beverton and Holt 1957).

Age estimation work will be done at the ADF&G Mark, Tag and Age Lab - Age Determination Unit⁴. All shell age estimation will be in accordance with the methods detailed in Siddon et al. 2017.

DATA ANALYSIS

Abundance and biomass indices of the surveyed population will be based upon area-swept calculations grouped by size class. Scallop density (catch per unit effort) within a given tow (U_i) will be calculated as

$$U_i = \frac{c_i}{a_i} \quad (1)$$

where

$$a_i = d_i x q \quad (2)$$

and

$$\bar{U} = \frac{1}{n} \sum_{i=1}^n U_i \quad (3)$$

c_i = the catch of scallops, either as a count or weight (lbs), in sample tow i ,

a_i = the effective area (nm^2) sampled in tow i ,

d_i = the distance (nm) of a sampled tow i ,

x = the width of the dredge (nm),

q = dredge efficiency (i.e. catchability),

n = the number of stations sampled.

A preliminary q of 0.83 calculated from the Kayak Island beds in 2004 (Gustafson and Goldman 2012) was used in lieu of bed or size specific efficiencies. It is important to clarify that q used in this analysis is a ‘bulk’ dredge efficiency applied to all size classes, which likely is not representative of the true catchability. Thus, estimates including q (e.g., catch per unit effort, abundance, biomass) should be regarded as indices, rather than absolutes. Variance in \bar{U} is estimated as

⁴ <https://mtalab.adfg.alaska.gov/ADU/Default.aspx> (accessed November 30, 2021).

$$\widehat{Var}[\bar{U}] = \frac{1}{n(n-1)} \sum_{i=1}^n (U_i - \bar{U})^2 \quad (4)$$

Surveyed population abundance (\hat{N}) and round weight (i.e., whole animal) biomass (\hat{B}) of large and small scallops will be computed by expanding \bar{U} over the entire bed area (A) (nm^2) as

$$\tau = A\bar{U} \quad (5)$$

where τ represents either \hat{N} or \hat{B} . Variance in \hat{N} and \hat{B} will be estimated as

$$\widehat{Var}[\tau] = A^2 \widehat{Var}[\bar{U}] \quad (6)$$

Although abundance and round weight biomass might be more directly indicative of population dynamics, meat weight biomass (B_M) is an important quantity for interpreting the proportion of biomass that is commercially available, as guideline harvest levels are set and managed in pounds of shucked meats. B_M is estimated via

$$\hat{B}_M = A \cdot \frac{1}{n} \sum_{i=1}^n u_i \quad (7)$$

u_i = the meat weight density (catch per unit effort) within sample tow i , in which

$$u_i = \frac{\hat{w}_i}{a_i} \quad (8)$$

$$\hat{w}_i = c_i \bar{w}_i \quad (9)$$

$$\bar{w}_i = \frac{1}{m_i} \sum_{j=1}^{m_i} w_{ij} \quad (10)$$

c_i = the total number of scallops caught in sample tow i .

m_i = the number of scallops subsampled from sample tow i (i.e., $m_i = 10$),

w_{ij} = the meat weight (g) of scallop j subsampled from the catch of tow i .

Variance in \hat{B}_M is then estimated as

$$\widehat{Var}[\hat{B}_M] = A^2 \widehat{Var}[\bar{u}] + \frac{A}{n} \sum_{i=1}^n c_i^2 \widehat{Var}[\bar{w}_i] \quad (11)$$

$$\widehat{Var}[\bar{w}_i] = \frac{1}{m_i(m_i - 1)} \sum_{j=1}^{m_i} (w_{ij} - \bar{w}_i)^2 \quad (12)$$

$$\widehat{Var}[\bar{u}] = \frac{1}{n(n - 1)} \sum_{i=1}^n (u_i - \bar{u})^2 \quad (13)$$

Meat weight biomass is only reported for scallops of the large size class (≥ 100 mm).

DATA INTEGRITY

Survey data will be entered after the survey into the scallop dredge survey database in Kodiak. Data will be maintained in this relational database and made available to ADF&G researchers and managers statewide. Raw datasheets will be scanned with both digital copies and physical sheets archived.

SURVEY LOGISTICS

Since 2016, the emphasis has been to conduct surveys in Westward Region and Southeast Region on a biennial rotation based on historic fishery catch amounts. Beds in the Central Region (Cook Inlet, Area H and Prince William Sound, Area E) have been surveyed within this rotation as funding and priorities have allowed (Table 3). The same rotation will be maintained for the years covered in this operational plan, with Westward Region, Area K and Central Region, Area H (Figure 1) being surveyed in even years and Southeast Region, Area D and Central Region, Area E (Figure 2) being surveyed in odd years.

SCHEDULE AND DELIVERABLES

Time Frame	Activity
Jan-March	Survey preparation.
April/May	Conduct survey.
May/June	Data entry, QA/QC, and archiving.
June/July	Data analysis and draft results submitted to fishery managers.
February- June	Scallop age determination.
January	Draft report for internal review.
March	Report published.

RESPONSIBILITIES

Kodiak

Fisheries Biologist II (PCN 11-1354, currently Ryan Burt)

Duties: Project lead, coordinate operational plan development, assist with survey budget management, develop survey schedules, assist with logistics. Ensure all data collection and management activities/methods conform with established program data collection/management standards and protocols. Act as cruise leader as needed, assist with sampling gear preparation, at-sea data collection, data entry and data management. Oversee post-survey data verification/editing and improvements to data quality assurance and control practices. Assist with data analysis and report writing.

Fisheries Biologist I (PCN 11-1403, currently Alyssa Hopkins)

Duties: Assist project lead with operational plan development, survey schedules and logistics. Act as cruise leader as needed, assist with sampling gear preparation, at-sea data collection, data entry and data management. Assist with post-survey data verification/editing and improvements to data quality assurance and control practices as needed. Assist with data verification/editing as needed. Assist with data analysis and report writing.

Fisheries Biologist III (PCN 11-1432, currently Bo Whiteside)

Duties: Project manager, provide budget oversight, coordinate with ADF&G Procurement and Department of Administration staff regarding survey vessel contractual and equipment procurement processes, and review project objectives and deliverables.

Biometrician II (PCN 11-0107, currently Tyler Jackson)

Duties: Serve as project biometrician, provide input on sampling design and effort allocation, contribute to survey data analysis and report writing. Assist with operational plan development.

Analyst/Programmer IV (PCN 11-1225, currently Ric Shepard)

Duties: Develop and maintain database design and structure, intranet pages and data entry/management applications. Load and manipulate data, create queries of finalized data for biometric analysis and report writing and assist in ensuring data management activities/methods conform with established program data collection/management standards and protocols.

Homer

Fisheries Biologist II (PCN 11-5187, currently Mike Byerly)

Duties: Assist project lead with operational plan development, survey schedules and logistics. Act as cruise leader as needed, assist with sampling gear preparation, at-sea data collection, data entry and data management. Assist with post-survey data verification/editing and improvements to data quality assurance and control practices as needed. Assist with data verification/editing as needed. Assist with data analysis and report writing.

Research Analyst II (PCN 11-7020, currently Chris Russ)

Duties: Assist with GIS related aspects of survey program. Produce maps of stations to be fished, associated files to be loaded into the chartered vessels navigation software for use by the captain and assist in map creation for reports.

Juneau

Fisheries Biologist III (PCN 11-6139, currently Kevin McNeel)

Duties: Oversee coordination of scallop shell age determination. Ensure all data collection and management activities/methods conform with established program data collection/management standards and protocols as well as oversee data verification/editing and improvements to data quality assurance and control practices.

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TABLES AND FIGURES

Table 1.—Select statewide weathervane scallop bed codes and descriptions list.

Registration Area	Management District	Bed	Bed Code	Bed Description
D	YAK	EK1	YAKB	portion of bed on Area D side, east of Kayak Island, along the Area E and D boundary within statistical areas 19110 and 18950 (YAKB and EK1 are the same bed biologically)
D	YAK	YAK1	YAK1	bed south of the mouth of Kaliakh River within statistical areas 19110 and 18950
D	YAK	YAK2	YAK2	bed south of Cape Yakataga within statistical areas 19110 and 18951
D	YAK	YAK3	YAK3	bed south of Icy Bay running to southeast of Yakutat Bay within statistical areas 18950, 18940 and 18930
D	YAK	YAK4	YAK4	bed south of Yakutat running to south of mouth of Akwe River within statistical areas 18930 and 18160
D	YAK	YAK5	YAK5	bed south of Dry Bay within statistical areas 18930, 18160 and 18110
D	YAK	YAK6	YAK6Y	portion of bed within Yakutat District, east of Cape Fairweather running to south of Lituya Bay within statistical areas 18930, 18110 and 15600 (YAK6Y and YAK6D are the same bed biologically)
D	YAK	YAK6	YAK6D	portion of bed within historic District 16, east of Cape Fairweather running to south of Lituya Bay within statistical areas 11614, 11612 and 15600 (YAK6D and YAK6Y are the same bed biologically)
E	EKI	EK1	EK1	bed south and east of Kayak Island to Area E and D boundary within statistical areas 445931 and 445932 (YAKB and EK1 are the same bed biologically)
E	WKI	WK1	WK1	bed south and west of Kayak Island within statistical areas 445931 and 445932
H	KAM	KAMN	KAMN	bed east of Augustine Island mostly within statistical area 535906
H	KAM	KAMS	KAMS	bed south and east of Augustine Island mostly within statistical area 525902
K	KNE	KNE1	KNE1	bed east of Marmot Bay outside closed area along border of statistical areas 515730 and 515802
K	KNE	KNE2	KNE2	bed within Chiniak Gulley along border of statistical areas 515700 and 515730
K	KNE	KNE3	KNE3	bed south of Ugak Island within statistical area 525702
K	KNE	KNE4	KNE4	bed at confluence of statistical areas 525702, 515700, 525630 and 515630
K	KNE	KNE5	KNE5	bed on east side of statistical area 525630
K	KNE	KNE6	KNE6	bed on west side of statistical area 525630

-continued-

Table 1.–Page 2 of 2.

Registration Area	Management District	Bed	Bed Code	Bed Description
K	KSH	KSH1	KSH1	bed between Cape Douglas and Hallo Bay on mainland side of Shelikof Strait within statistical areas 535802, 535831, 535832 and 535801
K	KSH	KSH2	KSH2	bed east of Kafliia Bay and Kukak Bay on mainland side of Shelikof Strait within statistical areas 545802 and 535801
K	KSH	KSH3	KSH3	bed within Kuliak Bay on mainland side of Shelikof Strait within statistical area 545802
K	KSH	KSH4	KSH4	bed north of the mouth of the Karluk River between Cape Uyak and Cape Karluk on Kodiak Island within statistical area 545733
K	KSH	KSH5	KSH5	bed between Cape Karluk and Sturgeon Head on Kodiak Island within statistical area 545733
K	KSH	KSH6	KSH6	bed between Sturgeon Head and Cape Grant on Kodiak Island within statistical area 545701
K	KSH	KSH7	KSH7	bed outside of Halibut Bay on Kodiak Island within statistical area 545701

Table 2.–Objective criteria for removal and addition of 1-nmi² stations for bed specific sampling frames.

Bed Grid Change	Criteria
Removal	<p>Commercial fishing location data used for initial grid development contained errors.</p> <p>Commercial fishing location data used for initial grid development determined not to characterize the tow path.</p> <p>Habitat determined to be non-scallop habitat.</p> <p>The proportion of towable seafloor within a station is too small to achieve a 1-nmi tow.</p> <p>Station contains too steep a slope to fish dredge effectively.</p> <p>Station determined as rocky or complex seafloor that would increase the likelihood of hang-ups and damage to the dredge.</p> <p>Depth is too great to achieve appropriate tow cable scope.</p> <p>Depth is too shallow to achieve appropriate tow cable scope.</p>
Addition	<p>New commercial fishing location data acquired since initial grid development.</p> <p>Location determined to be scallop habitat through other data sources (e.g. CamSled surveys, exploratory tows).</p> <p>Commercial fishing location data used for initial grid development contained errors.</p>

Table 3.—Beds surveyed since the 2016 weathervane scallop dredge survey (X) and regions to be surveyed from 2021 to 2023 in gray.

<u>Year</u>	<u>Westward Region Beds</u>									<u>Central Region Beds</u>				<u>Southeast Region Beds</u>						
	<u>Area K (KNE)</u>						<u>Area K (KSH)</u>			<u>Area H (KAM)</u>		<u>Area E</u>		<u>Area D (YAK)</u>						
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>S</u>	<u>N</u>	<u>WK1</u>	<u>EK1</u>	<u>B</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
2016							X	X	X			X	X							
2017		X	X			X	X	X						X	X	X		X	X	
2018							X			X	X		X		X	X	X			
2019											X	X		X			X	X	X	
2020	X	X	X	X	X	X	X													
2021												X	X	X	X	X	X	X	X	X
2022																				
2023																				

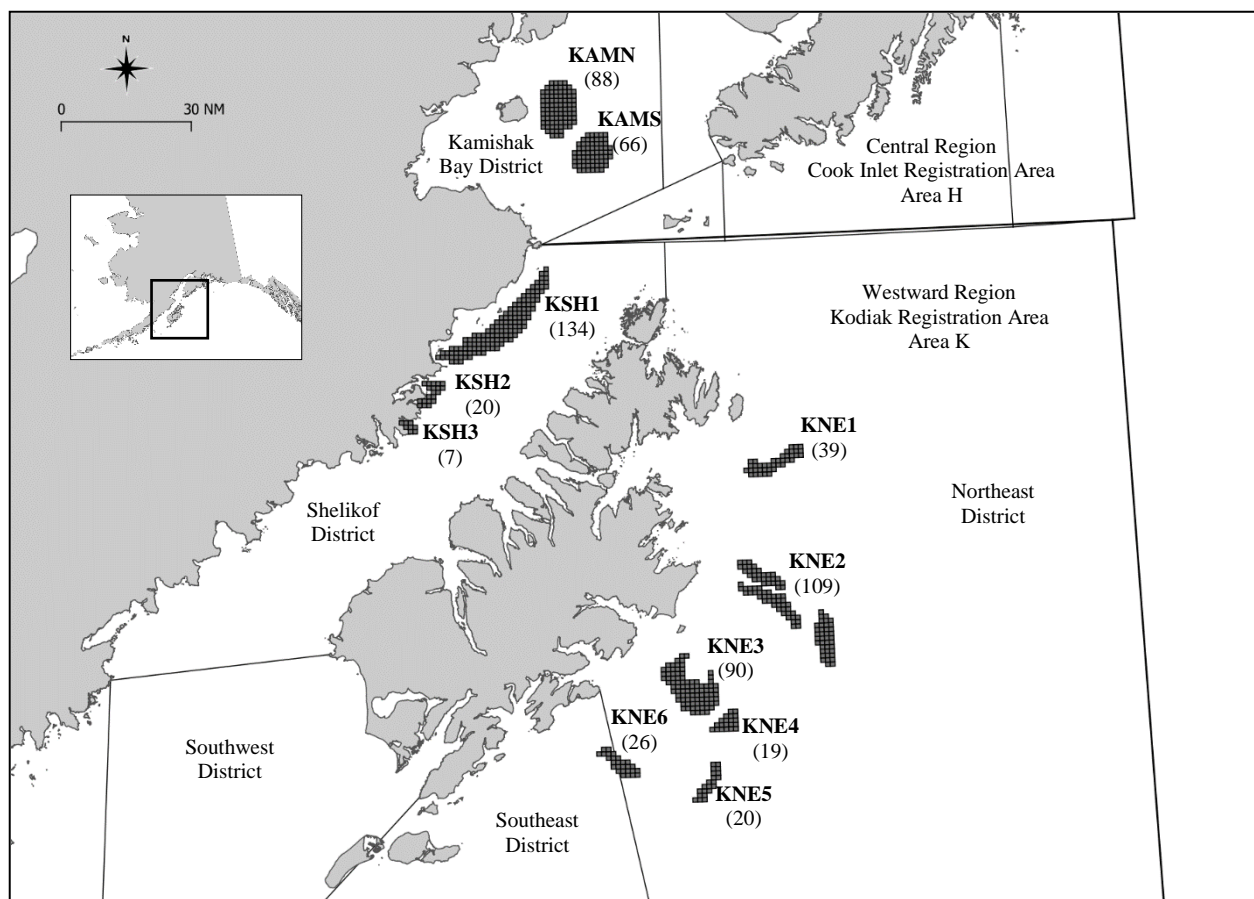


Figure 1.—Weathervane scallop dredge survey locations in the Central Region, Cook Inlet Registration Area, Area H and Westward Region, Kodiak Registration Area, Area K.

Note: Parentheses contain the number of stations in each bed.

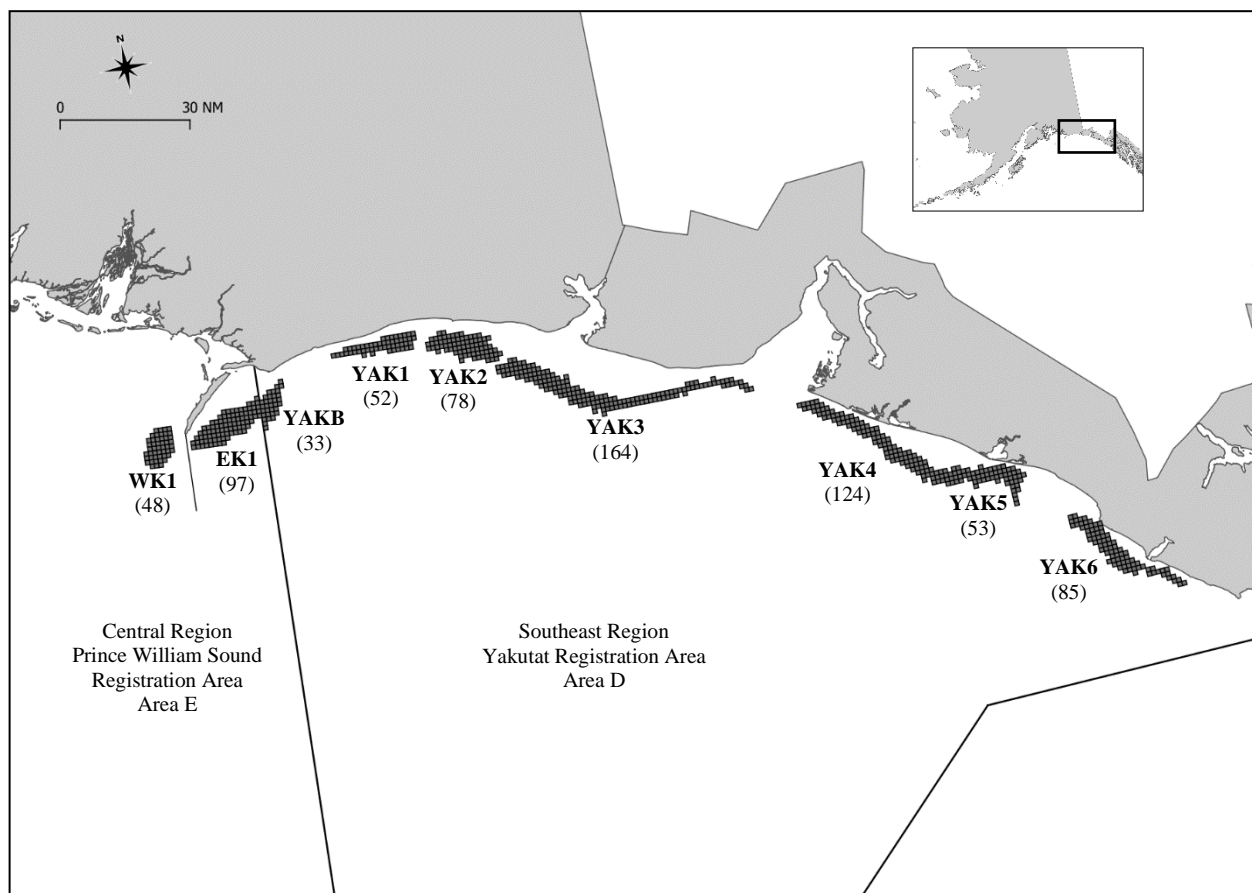


Figure 2.—Weathervane scallop dredge survey locations in the Central Region, Prince William Sound Registration Area, Area E and Southeast Region, Yakutat Registration Area, Area D.

Note: Parentheses contain the number of stations in each bed.



Figure 3.—New Bedford style scallop survey dredge.

APPENDICES

Appendix 1.-Fishing Log for Alaska Scallops Data Form.

Fishing Log For Alaska Scallops

Captain Name: _____

Survey Area: _____

ADF&G Number : _____

Cruise Number	Haul Number	Haul Type	Set Date (mm-dd-yy)	Bed Code	Station	Gear Code	Gear Sensor(s)

Haul Setting and Towing						
Latitude (N) (dd° mm.mm)	Longitude (W) (ddd° mm.mm)	Compass Heading (true bearing)	Start Depth (fathoms)	Time Haul Start (0000-2359)	Tow Cable Out (fathoms)	
Dredgemaster Target Angle	Average Speed (knots)	Average Depth (fathoms)	Weather		Surface Temp. (°C)	
			Wind	Swell		

Haul Retrieval						
Latitude (N) (dd° mm.mm)	Longitude (W) (ddd° mm.mm)	End Depth (fathoms)	Time Haul End (0000-2359)	Haul Duration (minutes)	Haul Distance (nmi)	Gear Performance

Haul Comments (Dredgemaster or gear problems, snags, pots or trees in gear, weather, tides, etc.)

HAUL TYPE:	
Code	Definition
10	= Regular survey haul (standard 15 minute, 1nmi hauls using a research dredge)
11	= Dredge catch comparison haul (using research or commercial dredges)
12	= Exploratory haul (using research or commercial dredges)
13	= Catch efficiency haul (using research or commercial dredges)
14	= Dredgemaster target angle study haul (using research or commercial dredges)

GEAR CODE:	
Code	Definition
1	= 8 ft. wide research dredge with 4 in. ring bag and 1.5 in. mesh liner (Homer)
2	= 8 ft. wide research dredge with 4 in. ring bag and 1.5 in. mesh liner (Kodiak)
3	= 15 ft. wide commercial dredge with 4 in. ring bag (Provider)

GEAR SENSOR(S):	
Code	Definition
1	= Dredgemaster
2	= Camera
3	= Logger
4	= Inclinator

BED CODE:	
See Statewide Scallop Bed Codes and Definitions List	

GEAR PERFORMANCE:	
Code	Definition
1	= Satisfactory: all dredges
2	= Satisfactory, minor problem: one dredge satisfactory, one unsatisfactory
3	= Satisfactory, minor problem: minor ring bag hang up or tear
4	= Satisfactory, minor problem: caught crab pot
5	= Unsatisfactory: all dredges
6	= Unsatisfactory: ring bag hung up
7	= Unsatisfactory: ring bag torn
9	= Unsatisfactory: caught crab pot
12	= Unsatisfactory: dredge flipped or upside-down
13	= Unsatisfactory: dredge muddied down
16	= Unsatisfactory: gear lost
17	= Unsatisfactory: sweep chain broke

WEATHER:			
WIND:		SWELL:	
Code	Definition	Code	Definition
1	= Calm - Sea surface smooth and mirror-like. Wind speed = 0-1 knots.	1	= 0 - 2 ft
2	= Light Air - Ripples with the appearance of scales are formed, but without foam crests. Wind speed = 1-3 knots.	2	= 2 - 4 ft
3	= Light Breeze - Small wavelets, still short, but more pronounced. Crests have a glassy appearance and do not break. Wind speed = 4-6 knots.	3	= 4 - 6 ft
4	= Gentle Breeze - Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses. Wind speed = 7-10 knots.	4	= 6 - 8 ft
5	= Moderate Breeze - Small (1-4 ft) waves becoming larger; fairly frequent white horses. Wind speed = 11-16 knots.	5	= 8 - 10 ft
6	= Fresh Breeze - Moderate (4-8 ft) waves taking a more pronounced long form; many white horses are formed. Chance of some spray. Wind speed = 17-21 knots.	6	= 10 - 12 ft
7	= Strong Breeze - Large (8-13 ft) waves begin to form; the white foam crests are more extensive everywhere. Probably some spray. Wind speed = 22-27 knots.	7	= 12 - 14 ft
8	= Near Gale - Moderately high (13-20 ft) waves and white foam from breaking waves begins to be blown in streaks along the direction of the wind. Wind speed = 28-33 knots.	8	= 14 - 16 ft
9	= Gale - Moderately high (13-20 ft) waves of greater length; edges of crests begin to break into spindrift. The foam is blown in well-marked streaks along the direction of the wind. Wind speed = 34-40 knots.	9	= Over 16 ft
10	= Strong (or Severe) Gale - High (20 ft) waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility. Wind speed = 41-47 knots.	Data Entry Tracking Enter your initials here when data has been entered into database:	
11	= Storm - Very high (20-30 ft) waves with long overhanging crests. The resulting foam, in great patches, is blown in dense white streaks along the direction of the wind. On the whole the surface of the sea takes on a white appearance. The 'tumbling' of the sea becomes heavy and shock-like. Visibility affected. Wind speed = 48-55 knots.		
12	= Violent Storm - Exceptionally high (30-45 ft) waves (small and medium-size ships might be for a time lost to view behind the waves). The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility affected. Wind speed = 56-63 knots.		

Alaska Department of Fish and Game - Scallop Research - Fishing Log For Alaska Scallops - Survey (Rev. March 16, 2019)

-continued-

Instructions for the Fishing Log For Alaska Scallops

Captain Name - First and last name of captain filling out logbook.

Survey Area - General area where survey was conducted.

ADF&G Number - 5-digit vessel identification number issued by the State of Alaska.

Cruise Number - 4-digit code used to identify the survey (assigned before survey commences). The first two digits represent the last two digits of the year the survey is conducted, and the last two digits represent the cruise (which is sequential depending on how many different vessels conduct a survey). Example: 2019 survey on the Provider cruise number is 1901.

Haul Number - Record a consecutive haul number for each tow made. All hauls must be recorded regardless of gear performance. Haul numbers begin at 1 at the start of each cruise.

Haul Type - Objective (or purpose) of the haul. See Haul Type list at bottom of form.

Set Date - Date haul was set. Record as mm-dd-yy.

Bed Code - Unique scallop bed code. See the Statewide Scallop Bed Codes and Definitions List.

Station - Identification number of the survey station. See Station Number List⁵.

Gear Code - Code that represents the dredge used during the haul. Codes to use are listed at bottom of form.

Gear Sensor(s) - Code(s) that represents the sensors (if any) mounted on the dredge to collect data while fishing. Codes to use are listed at bottom of form.

Haul Setting and Towing

Details of setting and towing the dredge for a haul.

Latitude - Latitude (N) of the beginning of haul. Record in degrees and decimal minutes (dd° mm.mm).

Longitude - Longitude (W) of the beginning of haul. Record in degrees and decimal minutes (ddd° mm.mm).

Compass Heading - Vessel heading (True Bearing) during haul.

Start Depth - Depth at the beginning of haul. Record in fathoms.

Time Haul Start - Time dredge begins fishing. Record as 0000-2359.

Tow Cable Out - Length of tow cable deployed for haul. Record in fathoms.

Dredgemaster Target Angle - Desired (targeted) pitch angle of the dredge for the haul.

Average Speed - Average vessel speed during haul. Record in tenths of a knot.

Average Depth - Average depth of entire haul. Record in fathoms.

Weather (Sea State) - Details of wind speed as well as wave and swell height during the haul.

Wind - See Beaufort scale text and pictures document for detailed descriptions. Codes to use are listed at bottom of form.

Swell - Estimated height of swell waves. Codes to use are listed at bottom of form.

Surface Temperature - Temperature of sea surface during haul. Record in °C.

-continued-

⁵ Master station number list is housed in Kodiak on database server: koddata, database: scalsurvey, schema: lut, table: station.

Haul Retrieval

Details of retrieving the dredge for a haul.

Latitude - Latitude (N) of the end of haul. Record in degrees and decimal minutes (dd° mm.mm).

Longitude - Longitude (W) of the end of haul. Record in degrees and decimal minutes (ddd° mm.mm).

End Depth - Depth at end of haul. Record in fathoms.

Time Haul End - Time dredge stops fishing. Record as 0000-2359.

Haul Duration - Time in minutes dredge was fished during haul.

Haul Distance - Distance in nautical miles dredge was fished during haul.

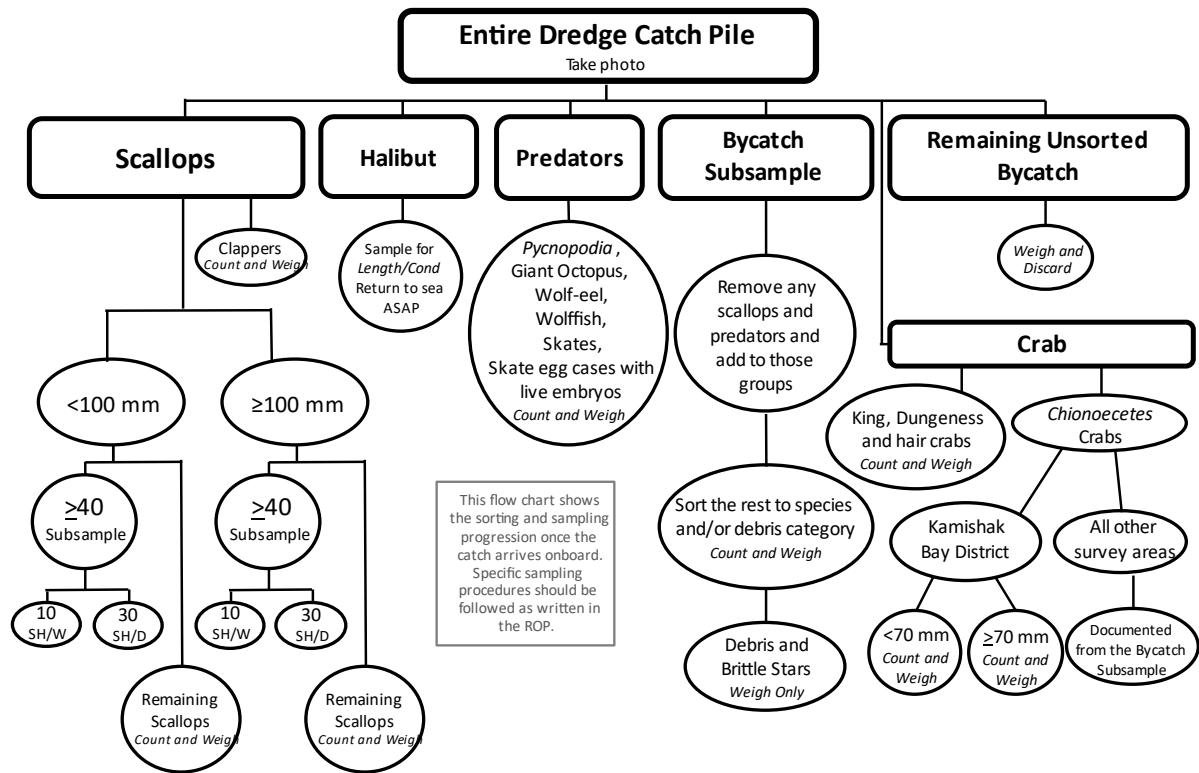
Gear Performance - Gear performance codes to use are listed at bottom of form.

Haul Comments - Comments related to Dredgemaster sensor and dredge performance or catch, weather and tides, or any pertinent information related to the haul.

Data Entry Tracking (bottom right corner of form) - Initial this box once data has been entered into database.

Appendix 2.–Flow diagram of on-deck catch sampling.

Regular Dredge Survey Haul Catch Sampling Flow Chart



Alaska Department of Fish and Game/Scallop Research- Regular Dredge Survey Haul Catch Sampling Flow Chart (Rev. Jan 26, 2021)

Instructions for the Scallop and Haul Composition Sampling Form

Cruise Number - 4-digit code used to identify the survey (assigned before survey commences). The first two digits represent the last two digits of the year the survey is conducted and the last two digits represent the cruise (which is sequential depending on how many different vessels conduct a survey). Example: 2019 survey on the Provider cruise number is 1901.

Haul Number - Record a consecutive haul number for each tow made. All hauls must be recorded regardless of gear performance. Haul numbers begin at 1 at the start of each cruise.

Set Date - Date haul was set. Record as mm-dd-yy.

Sample Time - Time the haul was sampled. Record as 0000-2359.

Page blank of blank - Number of pages used to document the catch from the sampled haul. Use multiple pages if necessary.

Sampler(s) Initials - Initials of person(s) conducting sample.

Large Weathervane Scallops (≥ 100 mm shell height)

Use this section to record data collected from scallops in the large scallop sample group.

Species Code - 74120, 5-digit NMFS RACE Division species code for weathervane scallops.

Sample Type - 1, Whole sample (all large scallops are counted and weighed from each haul). See Sample Type codes list at bottom of form.

Sample Group - 1, Large scallops (≥ 100 mm shell height).

Basket ID - Identification label of sampled basket.

Number - Number of large scallops in sampled basket.

Weight - Weight of large scallops up to the nearest thousandths of kilogram (up to 3 decimal places).

Small Weathervane Scallops (< 100 mm shell height)

Use this section to record data collected from scallops in the small scallop sample group.

Species Code - 74120, 5-digit NMFS RACE Division species code for weathervane scallops.

Sample Type - 1, Whole sample (all small scallops are counted and weighed from each haul). See Sample Type codes list at bottom of form.

Sample Group - 2, Small scallops (< 100 mm shell height).

Basket ID - Identification label of sampled basket.

Number - Number of small scallops in sampled basket.

Weight - Weight of small scallops up to the nearest thousandths of kilogram (up to 3 decimal places).

Weathervane Clappers

Use this section to record data collected from scallops in the clapper sample group.

Species Code - 74125, 5-digit NMFS RACE Division species code for weathervane scallops.

Sample Type - 1, Whole sample (all clappers are counted and weighed from each haul).

Sample Group - 3, Clappers.

Number - Total number of clappers. Remember to break clappers apart as they are counted.

Weight - Total weight of clappers to the nearest thousandths of kilogram (up to 3 decimal places).

-continued-

Scallop Predators

Use this section to record data collected from specific scallop predators.

Species to Record - *Pycnopodia* starfish, giant octopus, wolf-eels, wolffish, all skate species and skate egg cases with live embryos.

Sample Type - 1, Whole sample (all the listed predators are counted and weighed from each haul). See Sample Type codes list at bottom of form.

Species Names - Accepted common names of species encountered in sample.

Species Code - 5-digit NMFS RACE Division species code. Reference the species code book for a full list of codes.

Number - Number of individuals of each species in sample.

Weight - Weight of each species up to the nearest thousandths of kilogram (up to 3 decimal places).

Catch Comments

Notes related to the composition of or the sampling of the catch.

Haul Composition

Species Names - Accepted common names of species encountered in sample.

Sample Type - The type of sample conducted (whole or subsample). See Sample Type codes list at bottom of form.

Species Code - 5-digit NMFS RACE Division species code. Reference the species code book for a full list of codes.

Number - Number of individuals of each species in sample.

Weight - Weight of each species up to the nearest thousandths of kilogram (up to 3 decimal places).

Data Entry Tracking (bottom right corner of form) - Initial this box once data has been entered into database.

Appendix 4.-Scallop Shell Height and Weight Data Form.

Scallop Shell Height and Weight Form

Cruise Number: _____ Set Date: _____ (mm-dd-yy) Page: _____ of _____
Haul Number: _____ Species Code: 74120 Sampler(s) Initials: _____

Sample Group	Shell Number	Whole Weight (g)	Sex	Gonad Cond.	Meat Cond.	Shell Height (mm)	Mud Blister	Shell Worms	Shell Damage	Shell Collect (1 = yes)	Meat Weight (g)
1	1										
	2										
	3										
	4										
	5										
	6										
	7										
	8										
	9										
	10										
2	11										
	12										
	13										
	14										
	15										
	16										
	17										
	18										
	19										
	20										

SAMPLE GROUP:
1 = large scallops (≥100mm SH)
2 = small scallops (<100mm SH)

SEX:
0 = unknown
1 = male
2 = female
3 = hermaphrodite

GONAD CONDITION:
0 = immature
1 = empty
2 = initial recovery
3 = filling
4 = full
5 = cannot determine

MEAT CONDITION:
0 = good
1 = weak

MUD BLISTER:
0 = zero%
1 = 1% - 24%
2 = 25% - 49%
3 = 50% - 74%
4 = 75% - 100%

SHELL WORMS:
0 = zero%
1 = 1% - 24%
2 = 25% - 49%
3 = 50% - 74%
4 = 75% - 100%

SHELL DAMAGE:
0 = undamaged
1 = broken margin
2 = cracked
3 = punctured
4 = broken hinge
5 = crushed
6 = previously damaged

Data Entry Tracking
Enter your initials here
when data has been
entered into database:

Instructions for the Scallop Shell Height and Weight Form

Cruise Number - 4-digit code used to identify the survey (assigned before survey commences). The first two digits represent the last two digits of the year the survey is conducted and the last two digits represent the cruise (which is sequential depending on how many different vessels conduct a survey). Example: 2019 survey on the Provider cruise number is 1901.

Haul Number - Record a consecutive haul number for each tow made. All hauls must be recorded regardless of gear performance. Haul numbers begin at 1 at the start of each cruise.

Set Date - Date haul was set. Record as mm-dd-yy.

Page blank of blank - Number of pages used to document the catch from the sampled haul. Use multiple pages if necessary.

Sampler(s) Initials - Initials of person(s) conducting sample.

Species Code - 5-digit NMFS RACE Division species code. Pre-filled. Use this form to record weathervane scallop data only (species code 74120).

Sample Group - 1, Large scallops (≥ 100 mm shell height) or 2, Small scallops (< 100 mm shell height).

Shell Number - Identification number of individual scallops in sample as well as the number to record on the scallop shell if collected for shell age estimation. Shell numbers to use during this sampling are 1 through 10 for large scallops (Sample Group 1) and 11 through 20 for small scallops (Sample Group 2).

Whole Weight - Whole body weight of scallop to the nearest gram.

Sex - Code that represents the sex of the scallop. See Sex codes list at bottom of form.

Gonad Condition - Code that represents the general condition (state of development) of the reproductive organ of the sampled scallop. See Gonad Condition codes list at bottom of form.

Meat Cond. - Scallop meat condition describes the general condition of the adductor muscle (meat) when an individual scallop is shucked. See Meat Condition codes list at bottom of form.

Shell Height - Scallop shell height measurements (mm).

Mud Blister - Percent surface area of the inside of the top valve affected by mud blisters. Record in 25% increments. See Mud Blister codes list at bottom of form.

Shell Worms - Percent surface area of the inside of the top valve affected by shell boring worms. Record in 25% increments. See Shell Worms codes list at bottom of form.

Shell Damage - Shell damage is determined by examining both the top and bottom valves of the scallops' shell. Both valves of each scallop should be examined because one side may show injuries and the other may not. See Shell Damage codes list at bottom of form.

Shell Collect - Record a 1 if the shell was collected for shell age determination; otherwise leave blank.

Meat Weight - Weight of the adductor muscle meat in grams. Do not include the sweet meat.

Data Entry Tracking (bottom right corner of form) - Initial this box once data has been entered into database.

Appendix 5.-Scallop Shell Height and Damage Data Form.

Scallop Shell Height and Damage Form

Cruise Number: _____

Set Date: _____
(mm-dd-yy)

Page: _____ of _____

Haul Number: _____

Species Code: 74120

Sampler(s) Initials: _____

Sample Group: _____

	Shell Damage	Shell Height (mm)		Shell Damage	Shell Height (mm)		Shell Damage	Shell Height (mm)
1			31			61		
2			32			62		
3			33			63		
4			34			64		
5			35			65		
6			36			66		
7			37			67		
8			38			68		
9			39			69		
10			40			70		
11			41			71		
12			42			72		
13			43			73		
14			44			74		
15			45			75		
16			46			76		
17			47			77		
18			48			78		
19			49			79		
20			50			80		
21			51			81		
22			52			82		
23			53			83		
24			54			84		
25			55			85		
26			56			86		
27			57			87		
28			58			88		
29			59			89		
30			60			90		

SAMPLE GROUP:
1 = large scallops (≥100mm SH)
2 = small scallops (<100mm SH)

SHELL DAMAGE:
0 = undamaged 3 = punctured 5 = crushed
1 = broken margin 4 = broken hinge 6 = previously damaged
2 = cracked

Data Entry Tracking
Initial when data has
been entered.

Alaska Department of Fish and Game - Scallop Research - Scallop Shell Height and Damage Form - Survey (Rev. January 26, 2021)

-continued-

Instructions for the Scallop Shell Height and Damage Form

Cruise Number - 4-digit code used to identify the survey (assigned before survey commences). The first two digits represent the last two digits of the year the survey is conducted and the last two digits represent the cruise (which is sequential depending on how many different vessels conduct a survey). Example: 2019 survey on the Provider cruise number is 1901.

Haul Number - Record a consecutive haul number for each tow made. All hauls must be recorded regardless of gear performance. Haul numbers begin at 1 at the start of each cruise.

Set Date - Date haul was set. Record as mm-dd-yy.

Species Code - 5-digit NMFS RACE Division species code. Pre-filled. Use this form to record weathervane scallop data only (species code 74120).

Page *blank of blank* - Number of pages used to document the catch from the sampled haul. Use multiple pages if necessary.

Sampler(s) Initials - Initials of person(s) conducting sample.

Sample Group - 1, Large scallops (≥ 100 mm shell height) or 2, Small scallops (< 100 mm shell height). Sample Group codes listed at bottom of form.

Shell Damage - Shell damage is determined by examining both the top and bottom valves of the scallops' shell. Both valves of each scallop should be examined because one side may show injuries and the other may not. See Shell Damage codes list at bottom of form.

Shell Height - Scallop shell height measurements (mm).

Data Entry Tracking (bottom right corner of form) - Initial this box once data has been entered into database.

Appendix 6.-Crab Measurement Data Form.

Crab Measurement Form

Cruise Number: _____

Set Date: _____
(mm-dd-yy)

Page: _____ of _____

Haul Number: _____

Sampler(s) Initials: _____

Species Code	Sex	Carapace Size (mm)	Right Chela Height (mm)	Shell Condition	Female Maturity	Eggs				Condition	Parasite(s)
						Clutch	Fullness	Egg Development	Clutch Condition		
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

SPECIES CODE:
 68560 = *Chionoecetes bairdi*
 68020 = Dungeness crab
 69322 = red king crab
 69323 = blue king crab
 69400 = hair crab
 68580 = *Chionoecetes opilio*
 68590 = *Chionoecetes hybrid*
 68541 = *Chionoecetes* sp.
 (mixed opilio and hybrid)

SEX:
 0 = unknown
 1 = male
 2 = female
 3 = hermaphrodite

SHELL CONDITION:
 0 = premolt / molting
 1 = soft / new pliable
 2 = new
 3 = old
 4 = very old / very very old

FEMALE MATURITY:
 0 = unknown
 1 = immature
 2 = mature

CONDITION:
 0 = uninjured
 1 = fresh injury
 2 = dead
 3 = previously dead

PARASITE(S):
 blank = none
 1 = B. callosus
 2 = nemertean worms
 3 = bitter crab
 4 = other
 5 = black mat
 6 = torch
 7 = cottage cheese
 8 = turbellarian worms
 9 = pepper crab
 10 = snailfish eggs
 12 = leatherback

EGGS:

CLUTCH FULLNESS:
 0 = no eggs
 1 = trace to 1/8 full
 2 = 1/4 full
 3 = 1/2 full
 4 = 3/4 full
 5 = 100% full

EGG DEVELOPMENT:
 1 = uneyed eggs
 2 = eyed eggs
 3 = hatching eggs

CLUTCH CONDITION:
 1 = no dead eggs
 2 = dead eggs < 20%
 3 = dead eggs > 20%
 4 = barren / clean setae
 5 = barren / matted setae
 6 = barren / no setae

Data Entry Tracking
 Enter your initials here
 when data has been
 entered into database:

Instructions for the Crab Measurement Form

Cruise Number - 4-digit code used to identify the survey (assigned before survey commences). The first two digits represent the last two digits of the year the survey is conducted, and the last two digits represent the cruise (which is sequential depending on how many different vessels conduct a survey). Example: 2019 survey on the Provider cruise number is 1901.

Haul Number - Record a consecutive haul number for each tow made. All hauls must be recorded regardless of gear performance. Haul numbers begin at 1 at the start of each cruise.

Set Date - Date haul was set. Record as mm-dd-yy.

Page blank of blank - Number of pages used to document the catch from the sampled haul. Use multiple pages if necessary.

Sampler(s) Initials - Initials of person(s) conducting sample.

Species Code - 5-digit NMFS RACE Division species code. See Species Codes list at bottom of form.

Sex - Code that represents the sex of the crab. See Sex codes list at bottom of form.

Carapace Size - Crab biological measurements in millimeters (measure to 0.1 mm if also collecting Right Chela Height data). Biological measurement is carapace width for *Chionoecetes* and Dungeness crabs. Biological measurement is carapace height for Lithodid and Hair crabs.

Right Chela Height - Greatest height of the right chela between spines on dorsal ridge. Measure to 0.1 mm.

Shell Condition - Code that represents the shell condition of the sampled crab. See Shell Condition codes list at bottom of form.

Female Maturity - Record the code that represents the maturity status of sampled female *Chionoecetes* crabs only. See Female Maturity codes list at bottom of form.

Clutch Fullness - Code that represents the amount of eggs present in relationship to the abdomen size. See Clutch Fullness codes list at bottom of form.

Egg Development - Code that represents the observed stage of egg maturity. See Egg Development codes list at bottom of form.

Clutch Condition - Code that represents the general overall condition of the eggs and setae. See Clutch Condition codes list at bottom of form.

Condition - Code that represents the general health of the animal. Ignore old injuries unless otherwise directed. See Condition codes list at bottom of form.

Parasite(s) - Code(s) that represent any observed parasite and/or disease. Differentiate each parasite and/or disease using a forward slash (/). The code for 'other' is to be used note the presence of a parasite or disease not listed. If used, describe, photograph and retain the entire crab for further analysis. See Parasite(s) codes list at bottom of form.

Data Entry Tracking (bottom right corner of form) - Initial this box once data has been entered into database.

Appendix 7.–Pacific halibut fork length (cm) to weight conversion list (kg).

Pacific Halibut Fork Length to Weight Conversion
(Pacific halibut species code is 10120)

Length/Weight		Length/Weight		Length/Weight		Length/Weight		Length/Weight		Length/Weight	
(cm)	(kg)	(cm)	(kg)	(cm)	(kg)	(cm)	(kg)	(cm)	(kg)	(cm)	(kg)
21	0.09	60	2.40	99	12.20	138	35.79	177	80.20	216	152.86
22	0.09	61	2.54	100	12.61	139	36.65	178	81.65	217	155.13
23	0.09	62	2.68	101	13.02	140	37.51	179	83.14	218	157.49
24	0.14	63	2.81	102	13.43	141	38.37	180	84.69	219	159.85
25	0.14	64	2.95	103	13.88	142	39.28	181	86.18	220	162.20
26	0.18	65	3.13	104	14.33	143	40.19	182	87.77	221	164.61
27	0.18	66	3.27	105	14.79	144	41.10	183	89.31	222	167.01
28	0.23	67	3.45	106	15.24	145	42.00	184	90.90	223	169.51
29	0.23	68	3.63	107	15.69	146	42.96	185	92.53	224	171.96
30	0.27	69	3.81	108	16.19	147	43.91	186	94.17	225	174.45
31	0.27	70	3.99	109	16.65	148	44.91	187	95.80	226	176.99
32	0.32	71	4.17	110	17.19	149	45.90	188	97.48	227	179.53
33	0.36	72	4.35	111	17.69	150	46.90	189	99.16	228	182.12
34	0.36	73	4.54	112	18.19	151	47.90	190	100.88	229	184.70
35	0.41	74	4.76	113	18.73	152	48.94	191	102.60	230	187.33
36	0.45	75	4.94	114	19.28	153	49.99	192	104.37	231	190.01
37	0.50	76	5.17	115	19.82	154	51.07	193	106.14	232	192.69
38	0.54	77	5.40	116	20.41	155	52.16	194	107.91	233	195.36
39	0.59	78	5.62	117	20.96	156	53.25	195	109.72	234	198.08
40	0.64	79	5.85	118	21.55	157	54.39	196	111.58	235	200.85
41	0.73	80	6.12	119	22.14	158	55.52	197	113.44	236	203.62
42	0.77	81	6.35	120	22.77	159	56.65	198	115.30	237	206.43
43	0.82	82	6.62	121	23.36	160	57.79	199	117.21	238	209.29
44	0.86	83	6.89	122	24.00	161	58.97	200	119.11	239	212.15
45	0.95	84	7.17	123	24.68	162	60.19	201	121.06	240	215.05
46	1.00	85	7.44	124	25.31	163	61.37	202	123.01	241	217.95
47	1.09	86	7.76	125	25.99	164	62.64	203	125.01	242	220.90
48	1.18	87	8.03	126	26.67	165	63.87	204	127.01	243	223.85
49	1.27	88	8.35	127	27.35	166	65.14	205	129.05	244	226.89
50	1.32	89	8.66	128	28.03	167	66.41	206	131.09	245	229.88
51	1.41	90	8.98	129	28.76	168	67.72	207	133.17	246	232.97
52	1.50	91	9.30	130	29.48	169	69.04	208	135.26	247	236.05
53	1.63	92	9.62	131	30.25	170	70.35	209	137.39	248	239.13
54	1.72	93	9.98	132	30.98	171	71.71	210	139.53	249	242.26
55	1.81	94	10.30	133	31.75	172	73.07	211	141.66	250	245.44
56	1.91	95	10.66	134	32.52	173	74.43	212	143.88		
57	2.04	96	11.07	135	33.34	174	75.84	213	146.06		
58	2.18	97	11.43	136	34.16	175	77.29	214	148.32		
59	2.27	98	11.79	137	34.97	176	78.70	215	150.55		